Resource Action: EWG-2A	**Task Force Recommendation Category:** 1

SPATIAL SEGREGATION AND ENUMERATION OF SALMON AND STEELHEAD RUNS

Related PM&Es:

- EWG-1 addresses a similar resource goal by different means.
- This PM&E incorporates previous PM&Es: EWG-2B, EWG-34, and EWG-41.
- EWG-101 is very similar and may be combined with this resource action.

1. PM&E Description:

One or more weirs would be installed in the low flow section of the Feather River to count passing fish, selectively pass desired fish, and/or block passage of undesired fish. Currently, fishes in the Feather River have free access into the low flow channel. This resource action would potentially accomplish several goals, specifically it would: 1) Address concerns about high densities of salmon spawning by controlling number of fish passing upstream, 2) Provide segregation between fall and spring run salmon (both hatchery and in-river), 3) Provide segregation between wild and hatchery origin salmon and steelhead, and 4) Allow collection of valuable data on timing, abundance and movements of Feather River fishes. Installation of fish weirs would provide a very flexible management tool for the low flow section of the Feather River. Weirs could be operated in many different ways to achieve resource goals while minimizing potential negative impacts. Likely weir locations, configurations and operational strategies are described further in the Design Considerations and Evaluation Section.

2. Project Nexus

This resource action is related to ongoing project operations and facility structures which impede or restrict passage of anadromous and migratory fish in the Feather River above the Oroville Facilities. The Feather River downstream of the Fish Barrier Dam does not permit the spatial segregation of spring and fall run Chinook salmon spawning. The Feather River Hatchery (FRH), which is intended to mitigate for loss of upstream habitat, also has been unable to successfully segregate spring and fall run Chinook salmon.

3. Potential Environmental Benefits:

Intense competition for limited spawning habitat, superimposition of redds, and introgression between salmon runs are thought to be serious problems on the Feather River. Segregation of spring and fall run salmon is of particular interest among members of the FERC collaborative. Installation of weirs would permit early arriving spring run salmon to over summer and spawn without interference from fish arriving in the fall. In-river segregation of spring run salmon would also permit the Feather River Fish Hatchery to collect spring run brood fish without potential introgression of fall run, and without having to hold spring run salmon in the Feather River Fish Hatchery. Members of the collaborative have also expressed a strong interest in expanding natural, in-river production of salmon and steelhead. Operation of weirs along with

an appropriate marking program at the hatchery would make it possible to selectively pass fish of natural origin. Weirs would also provide an important management tool by providing basic information about run timing, population size, and life history strategies.

4. Potential Constraints

Construction and operation of weirs anywhere on the Feather River will have impacts on fisheries and recreation. Weirs will present passage problems (delays or full impediment depending on specific weir operations) for migratory fishes. Weirs also have the potential to result in "take" of some species listed under state and federal Endangered Species Act. Passage of boats and swimmers could be somewhat impaired by weirs. However, the planned location for weirs in the low flow section would minimize recreation impacts. Also, the intended weir design is very safe for swimmers and can easily be modified to permit passage of boats. A number of permits will be required in order to install and operate weirs these include: Army Corps of Engineers, Nationwide Permit; NOAA Fisheries, Endangered Species Take Authorization; DFG, Streambed Alteration, Scientific Collecting Permit, CEQA; USFWS, NEPA.

5. Existing Conditions

The Feather River downstream of the Fish Barrier Dam provides approximately 16 river miles of spawning habitat for wild and hatchery origin spring-run, fall-run Chinook salmon and steelhead. Under current conditions substantial conflicts exist between these fishes, particularly in the low flow channel where the vast majority of spawning activity takes place. The habitat available for spawning does not permit the spatial segregation of in-river spawning spring and fall run Chinook salmon. Lack of segregation, combined with large numbers of fish, results in substantial superimposition of salmon redds and permits introgression between spring and fall run Chinook salmon. The Feather River Hatchery (FRH), which is intended to mitigate for loss of upstream habitat, also has been unable to successfully segregate spring and fall run Chinook salmon. The failure of spring and fall run segregation is evidenced by the apparent lack of genetic distinction between these two Chinook races. Under current conditions wild, natural produced salmon and steelhead appear to have little opportunity to reproduce without intense competition, predation and genetic introgression from hatchery origin salmonids. Fisheries biologists are currently lacking tools or methods to monitor basic aspects of salmonid populations in the Feather River. Population size, migratory behavior and life history strategies are largely unknown for ESA listed spring-run Chinook salmon and steelhead.

6. Design Considerations and Evaluation

Weirs would provide a flexible tool for addressing the goals and conditions already described. The following design and evaluation reflects only a few of the ways in which weirs might be designed and utilized in the low flow section of the Feather River.

Weir Locations. Fishery Task Force discussion and preliminary field evaluations have identified two likely sites for weir placement (Figure 1).

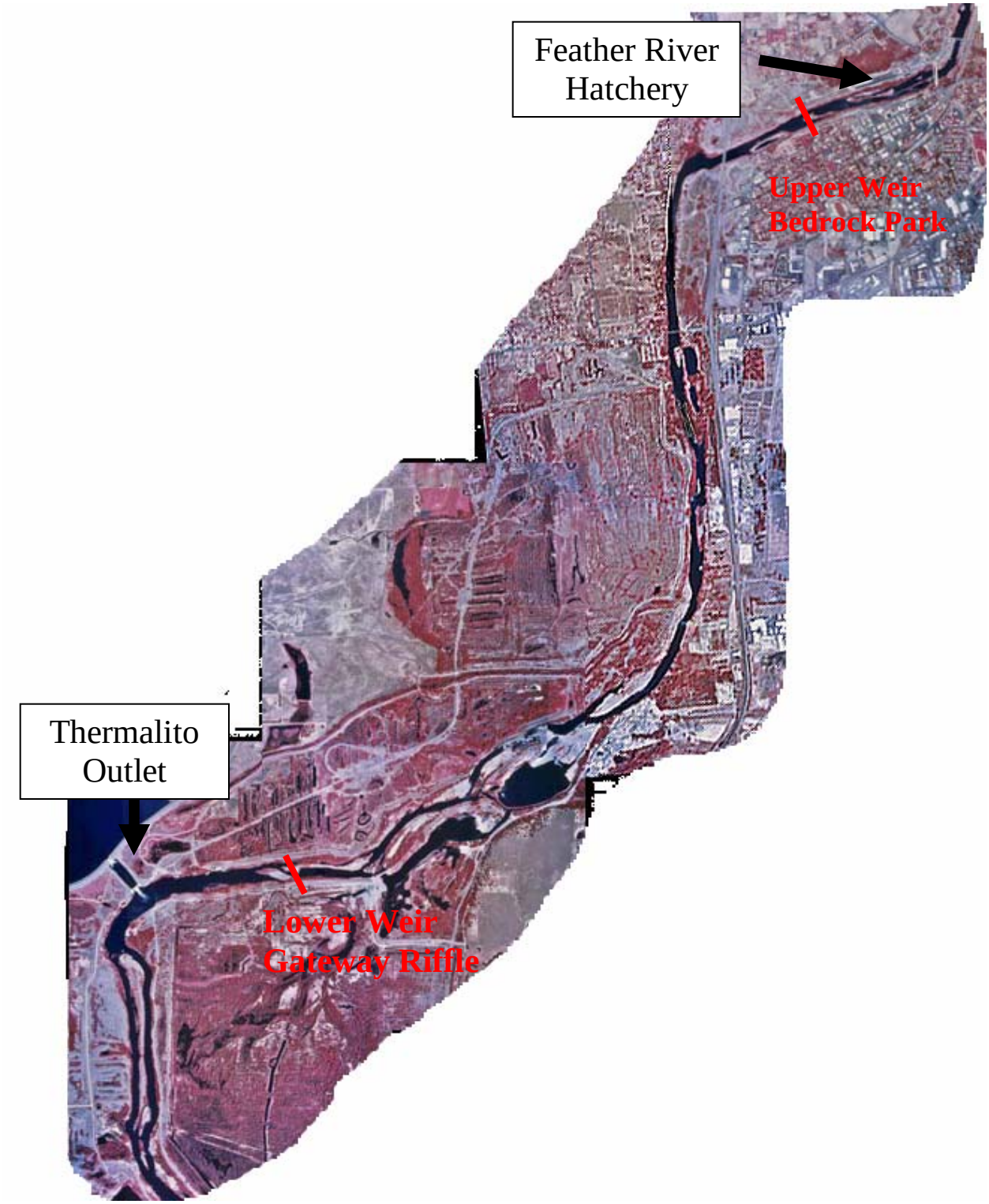

Figure 1. Approximate locations for Feather River weirs.

The Bedrock Park and Gateway Riffle weir locations are located at opposite ends of the low flow section, and as a result could be used to meet different purposes. The upper weir at Bedrock Park is well suited to providing a segregated area for spring run salmon, and is close enough to the FRH to allow for a possible, separate fall-run fish ladder entrance. The lower weir site at Gateway Riffle would be useful as monitoring facility, but could also be used to regulate fish passage into a larger portion of the low flow section. Both of the proposed weir locations are desirable because they occur in relatively straight channel areas with moderate current and depths.

Weir Design and Construction. A review of various weir design options found that the most suitable design followed that of the portable resistance board weirs (a.k.a. Alaskan weirs). Portable resistance board (PRB) weirs are a relatively new alternative to other weir designs and are capable of consistently providing reliable information, even in streams with that experience debris and high flow periods (Tobin 1994). PRB weirs are more capable than traditional weirs of withstanding high and fluctuating flows, and will temporarily submerge when pressure created by debris loading reaches a point that would wash out or impair the function of a traditional weir.

PRB weirs are composed of rectangular panels constructed from evenly spaced, vertically arrayed PVC pickets (Figure 2). The upstream end of each panel is hinged to a rail that is anchored in the stream bottom, and the downstream end is held at the water surface by a resistance board that planes upward in flowing water (Figure 3). When the panels are installed the barrier inhibits upstream migration of large fishes while allowing water to pass. The vertically oriented pickets permit most small debris to pass through the weir, while larger debris may pass over the top of the weir by temporarily submerging the impinged weir panels. Panels return to normal operating position once the large debris passes or is removed. If desired, one or more openings in the weir allow fish to be directed into a counting or containment area (Figure 4).

Figure 2. Rectangular panels, PVC pickets and resistance board are visible in this photograph.

Figure 3. Example of a portable resistance board weir spanning a large river.

Figure 4. Example of a live box that may be used along with a PRB weir to capture, enumerate or selectively pass migrating fishes.

By design, PRB weirs are relatively non-invasive structures and have the built-in ability to "collapse" or fold down in the downstream direction in order to allow floating objects to pass over them, before returning to their normal operating position. The ability for objects (boats, canoes, rafts, swimmers, etc.) floating downstream to safely pass over the structure unimpeded, is a significant advantage for minimizing impacts to recreational river users. In a survey of PRB

weir operators in California, Oregon, Washington, Idaho and Alaska, Demko (2001) found no operators that had any occurrence of accidents or injury to recreational river users.

Weir Operations. As stated earlier, weirs are appealing because the flexibility they provide in fishery management with relatively little cost, and without construction of large, permanent structures. Table 1 depicts a number of different weir operational strategies which might be employed to meet various fishery resource goals.

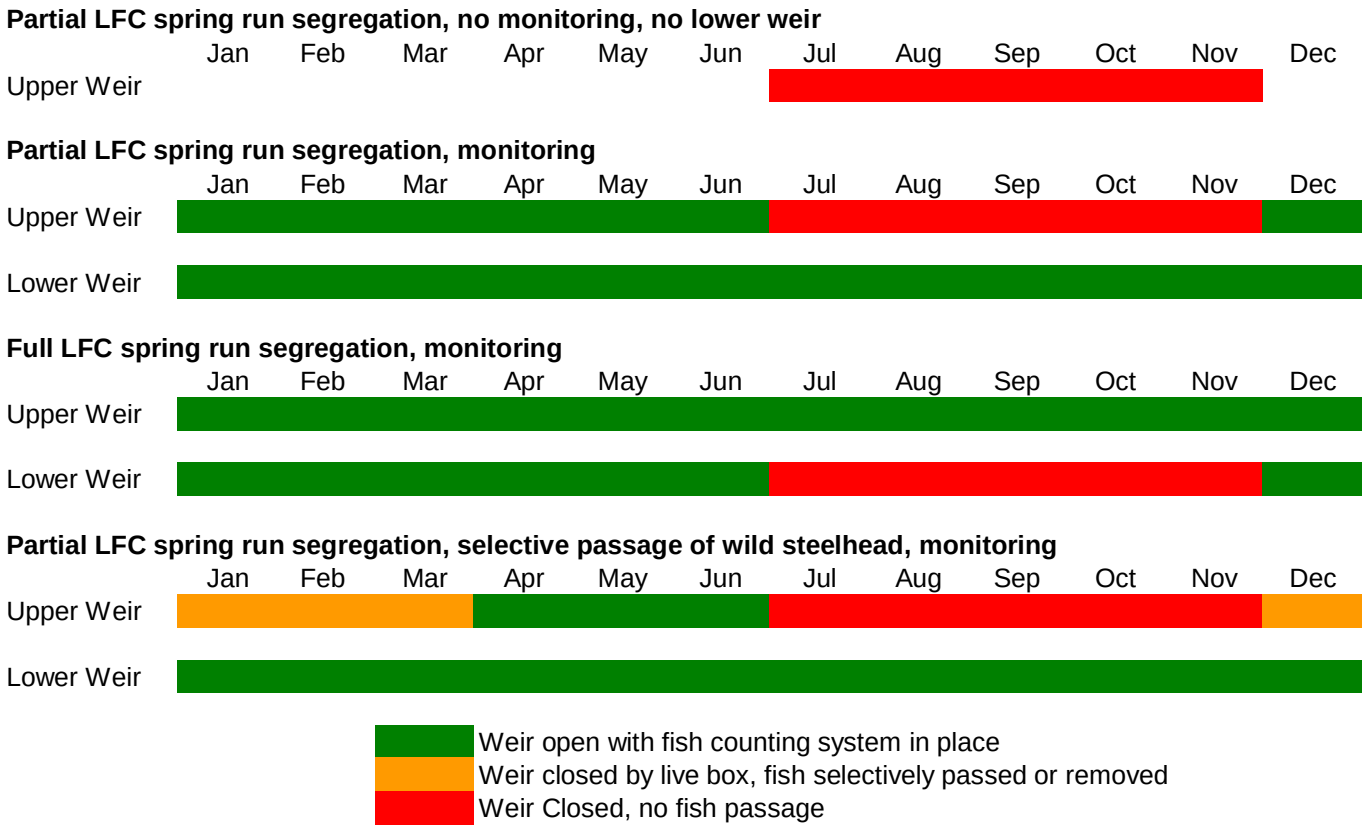

Table 1. Four potential operational strategies for low flow section weirs.

Additional Related Actions. Weir installation enables a number of other actions related to management of anadromous salmonids in the Feather River. These actions are relevant to consideration of the weir concept as a whole.

- Segregation of spring and fall run Chinook salmon at the FRH is a high priority for members of the EWG. Placement of the upper weir at Bedrock Park should be successful in segregating spring-run salmon, but will also inhibit collection of fall-run salmon through the existing fish ladder located at the Fish Barrier Dam. Thus, alternate means for getting fall run salmon into the FRH will need to developed. Fall-run might

be captured and trucked to the FRH. Alternatively, an on-river spawning station could also be established . Ultimately it might be desirable to build a secondary fish ladder from the Bedrock Weir into the FRH.

- In using weirs to monitor fish populations it would be desirable to have a non-invasive fish counting and identification system. This system would probably include some combination of infrared (e.g. Vaki RiverWatcher) and video counting systems. Equipment for detecting tags placed in fish might also be required (e.g. passive integrated tags, coded wire tags, radio/acoustic tags).
- Selective passage of wild or hatchery fish will require 100% marking of hatchery produced fish. This is already in place for steelhead and spring run Chinook salmon, but would require substantial additional expense and effort to achieve this with fall run.

7. Synergism and Conflicts

This resource action is compatible with the resource goals described in EWG-1, EWG-2B, EWG-34, EWG-41 and EWG-101 which relate to segregations of spring and fall run Chinook salmon. This resource goal might also be viewed as an alternative to others (e.g. EWG-97B, EWG-98) which seek to provide segregation (and natural production) of spring run salmon by creating or providing transport to new habitats. Additionally, the weir operations described would further resource goals of increasing natural production of salmonids and reducing superimposition of salmon redds.

Conflicts from this resource action will result primarily from impacts to fishing and boating recreation in the low flow section of the Feather River.

8. Uncertainties

PRB weirs have been used effectively in many rivers, uncertainties with their application in the Feather River result primarily from the large numbers of salmon and impacts to ESA listed species. For example, segregating spring run salmon may cause stress, disease and mortality among fall run salmon and steelhead that are prevented from passing upstream by a weir closure. Impacts to ESA listed species including Central Valley steelhead and spring run Chinook will need to be considered. We do not expect impacts to any other species listed under state or federal ESA. Further development this resource action should also consider a viable salmonid population analysis to help determine/validate weir placement.

9. Cost Estimate

Weirs such as those described here would cost approximately $75,000 to construct (each). Monitoring equipment for each weir would cost $50,000 to $100,000 (depending on the type of equipment installed). Thus, capital costs would likely range between $250,000 and $350,000 for two weirs equipped with monitoring equipment. Costs to operate the weir would be no more than 2 year-round field technicians, or approximately $146,000. Actual cost would probably be less because weirs would not be fully operated year-round.

10. Recommendations

This resource action holds substantial promise for efficiently addressing several significant fishery management issues in the lower Feather River. The tools and equipment required are readily available and have proven effective in many other river systems. This resource action should be further developed to provide more detailed specifications for operation strategies, design, placement, permit acquisition and costs.

11. Literature Cited

Demko, D. 2003. Adult Chinook enumeration and biological evaluation in the Stanislaus River using a portable resistance board weir. CalFed Proposal.

Tobin, J.H. 1994. Construction and performance of a portable resistance board weir for counting adult salmon in rivers. USFWS. Kenai, Alaska.